

# **The Oncologic Safety and Functional Preservation of Supraglottic Partial Laryngectomy**

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# **The Oncologic Safety and Functional Preservation of Supraglottic Partial Laryngectomy**

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## **Abstract**

### **The Oncologic Safety and Functional preservation of Supraglottic Partial Laryngectomy**

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From the aspect of the conservation of the larynx, radiation therapy has been evaluated to show excellent functional results in phonation and deglutition in comparison with surgical treatments, nonetheless in several studies, after radiation therapy, the impairment of voice and swallowing due to mucositis and late fibrosis has been reported. In addition, in cases that additional therapy has to be selected due to recurrence, there are certain limits for performing conservation laryngectomy, and thus it is required to consider whether radiotherapy is appropriate as the initial treatment. Therefore, in our study, by the comparative study of supraglottic partial laryngectomy (SPL) that allows functional conservation with radiation therapy, the appropriateness of the conservative surgery as the initial treatment for early supraglottic cancer was evaluated.

This study was performed from May 1991 to May 2005 on 48 patients

diagnosed as supraglottic cancer in the department of Otorhinolaryngology, Severance Hospital, and who underwent supraglottic partial laryngectomy and 20 patients treated with radiation therapy as the initial therapy. Their medical record was analyzed retrospectively, and the swallowing and phonation of patients whose treatment was completed by the initial treatment were evaluated. The results showed that a difference of the survival rate of the two groups was not detected, and in the evaluation of swallowing and phonation, functional preservation at comparable levels was confirmed.

Based on this, it is considered that for patients with supraglottic carcinoma, supraglottic partial laryngectomy provides an equal level of oncologic safety and functional preservation in comparison with radiation therapy.

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Key Words : supraglottic partial laryngectomy, radiation, deglutition, phonation



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## **I . INTRODUCTION**

Laryngeal tumors consists 2% of the entire tumors and shows the second highest incidence in the head and neck area.<sup>1</sup> Among them, approximately 1/3 occurs in the supraglottis, and 90% are pathologically squamous cell carcinomas.<sup>2</sup> Similar to other tumors of the head and neck, the primary purpose of treatment for supraglottic carcinoma is the radical resection of tumor, nevertheless, the conservation of laryngeal function is also an important issue to be considered. The therapeutic modes of supraglottic carcinoma that could be applied to selective early stage patients would be endoscopic resection, supraglottic partial laryngectomy, radiation therapy, and chemotherapy.

In early supraglottic carcinomas, high local control rates are anticipated with radiotherapy or surgery alone, however, from the aspect of the functional

preservation, radiation therapy is advantageous, and so it has been generally adopted as the initial therapy.<sup>3,4,5</sup> However, the impairments of swallowing and phonation caused by radiation therapy are being reported by many studies and excellent treatment results of surgical methods which have been underevaluated in terms of functional preservation have been reported and so, reevaluation of its appropriateness as the initial treatment for supraglottic carcinomas is considered necessary.<sup>10,11,12</sup>

Supraglottic partial laryngectomy has been reported by Alonso<sup>6</sup> in the 1940s for the first time, and it shows equal oncological results with total laryngectomy, and also, functional preservation of swallowing and phonation is possible with this technique. To date, studies on the treatment effectiveness or the conservation of laryngeal function after either conservation laryngeal surgery or radiation therapy alone have been conducted, nevertheless, comparative studies between the two treatment methods have hardly ever been conducted. In addition, the functional evaluation after supraglottic partial laryngectomy was limited to parameters such as the time of decannulation, aspiration and the ability for oral intake.

Therefore, this study aims to compare the oncologic safety between radiation therapy and supraglottic partial laryngectomy, and from the functional comparison of swallowing and phonation after treatment, the appropriateness of supraglottic partial laryngectomy as the initial treatment of supraglottic carcinomas has been evaluated.

## **II. MATERIAL AND METHODS**

Patients who were diagnosed as supraglottic carcinoma from May 1991 to May 2005 in the department of Otolaryngology, Head and Neck Cancer Clinic, Severance Hospital, were chosen for subjects of this study. From medical records of each patient, the age at diagnosis, gender, location of primary site, TNM disease stage, histological type, presence of recurrence and its site were retrospectively reviewed. In this study, the disease stage was determined according to the 2002 edition of the AJCC (American Joint Committee on Cancer) staging manual <sup>7</sup>.

68 patients were diagnosed as supraglottic carcinoma, and among them, 48 patients received supraglottic partial laryngectomy and 20 were treated with radiation therapy as initial treatment. Subjects were divided into two groups according to the mode of initial treatment, and the average age of each group was 62 years and 69 years. For each group, the number of patients diagnosed as stage I or II and whose treatment was completed by initial therapy was 15 in the supraglottic partial laryngectomy group and 10 in the radiation therapy group, and their mean age was 62 years and 69 years with all being males (Table 1)

Table 1. Patient characteristics

	Primary SPL (n=48)	Primary RTx (n=20)
Age	Mean 62yrs (41 to 83)	Mean 69yrs (48 to 91)
M : F	19:1	9:1
	Only SPL (n=15)	Only RTx (n=10)
Age	Mean 62yrs (46 to 68)	Mean 69yrs (58 to 80)
M : F	All male	All male

SPL:supraglottic partial laryngectomy, M:male, F:female

The clinical stage of the entire patient groups was analyzed according to the mode of initial treatment. In the supraglottic partial laryngectomy group, 25 patients were diagnosed as stage I or II (T1,T2), and for 3 patients diagnosed as T3, limited supraglottic partial laryngectomy was performed. (Table 2) In the radiotherapy group, 10 patients were diagnosed as stage I or II (T1,T2), and it was also applied to 4 patients diagnosed as T3. (Table 3)

Table 2. Clinical staging of primary SPL group (n=48)

cT	cN					T(n)
	N0	N1	N2a	N2b	N2c	
T1	12	2	-	1	-	15
T2	13	3	2	5	1	24
T3	3	-	-	2	4	9
Total	28	5	2	8	5	48

SPL: supraglottic partial laryngectomy

Table 3. Clinical staging of primary RTx group (n=20)

cT	cN					T(n)
	N0	N1	N2a	N2b	N2c	
T1	2	-	-	-	-	2
T2	8	-	2	1	1	12
T3	4	-	-	1	1	6
Total	14	-	2	2	2	20

To evaluate oncologic safety, the correlation of primary site and the resection margin was analyzed and survival rates of each group according to stage were compared.

In order to exclude influences from other treatments, Functional tests were performed only on the stage I and II patients whose treatment was completed by the initial treatment. Swallowing test was conducted in the Severance Rehabilitation Medicine Laboratory, utilizing the videoesophagofluoroscopy. The examination compared the two groups under the category of the pharyngeal phase and the presence or absence of aspiration. For phonation examination, acoustic waveform analysis and stroboscopy were performed at the Severance Voice Diagnostic Laboratory. Acoustic wave form analysis evaluated the variance against frequency, the variance against amplitude and the noise level, and stroboscopy analyzed specific categories of regularity, symmetry, glottic closure, mucosal wave, amplitude and non-vibrating portion.

Survival rates were calculated by the Kaplan-Meier method, and their

statistical significance was validated by Log-rank test. For the functional tests, chi-square test and t-test were applied for comparison between the two groups

### III. RESULTS

#### 1. The correlation of the primary site of tumor and the resection margin

The location of primary site was examined for each group. Overall, the epiglottis was the most common with 39 patients (57%), and depending on the relation of their location based on the hyoid, there was no difference in the incidence of the primary site. The false vocal cord and the aryepiglottic fold was detected in 17 patients (25%) and 12 patients (17%), respectively.

(Table 4)

Table 4. Primary site

Primary site	Primary SPL	Primary RTx	n (%)
Suprahyoid epiglottis	17	3	20 (29%)
Infrahyoid epiglottis	16	3	19 (29%)
False cord	10	7	17 (25%)
AEF	5	7	12 (17%)
Total	48	20	68 (100%)

SPL: supraglottic partial laryngectomy, AEF: aryepiglottic fold

In the supraglottic partial laryngectomy group, the pathology revealed 12 (25 %) out of total 48 cases with positive resection margins. Where the primary site was the suprahoid epiglottis, there were 2 cases (11 %, 2/17) with positive superior resection margins, and where the primary site was either the infrahyoid epiglottis or the false vocal cord, positive inferior resection margins were noted in 4 cases (25%, 4/16) and 2cases (20%, 2/10) respectively. (Table 5)

Table 5. Primary site with positive margin

Primary site	Positive margin	n (%)
Suprahoid epiglottis	BOT	2 (11%)
	Lateral margin	1 (5%)
Infrahyoid epiglottis	Ventricle	4 (25%)
	Lateral Margin	1 (6%)
AEF	BOT	1 (20%)
False cord	Ventricle	2 (20%)
	Lateral margin	1 (10%)
Total		12 (25%)

BOT: base of tongue, AEF: aryepiglottic fold



## 2. Analysis of survival rate

Survival rates of patients who were diagnosed as early supraglottic carcinoma (stage I or II) and whose treatment was initiated by supraglottic partial laryngectomy or radiation therapy were analyzed. The 5-year disease-free survival rate was 89% in patients whose treatment was initiated by supraglottic partial laryngectomy, and 100% in patients whose treatment was initiated by radiation therapy, with no significant difference ( $p=0.341$ ). The overall 5-year survival rate was 87% and 80%, respectively with no significant difference ( $p=0.428$ ) (Figure 1, 2)

Fig 1. Disease-free survival (stage I, II)

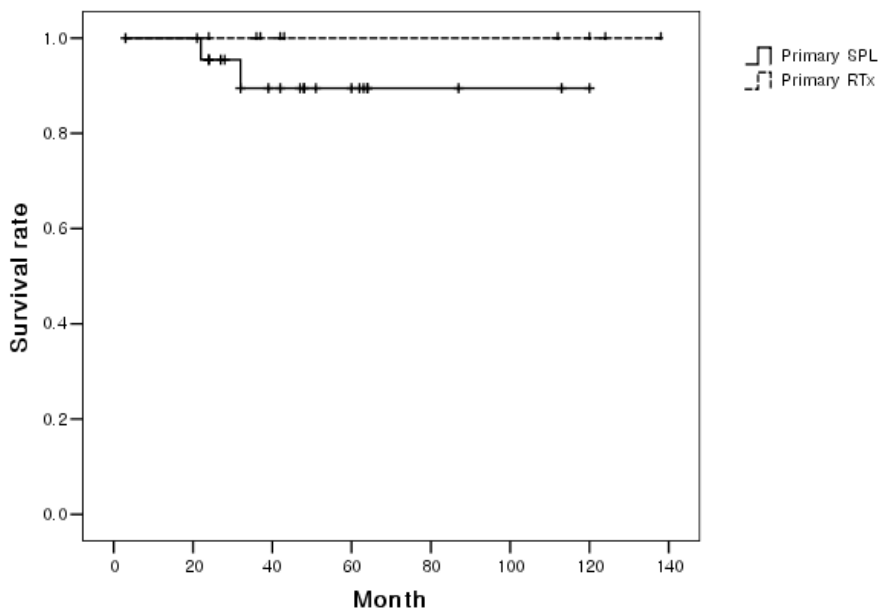
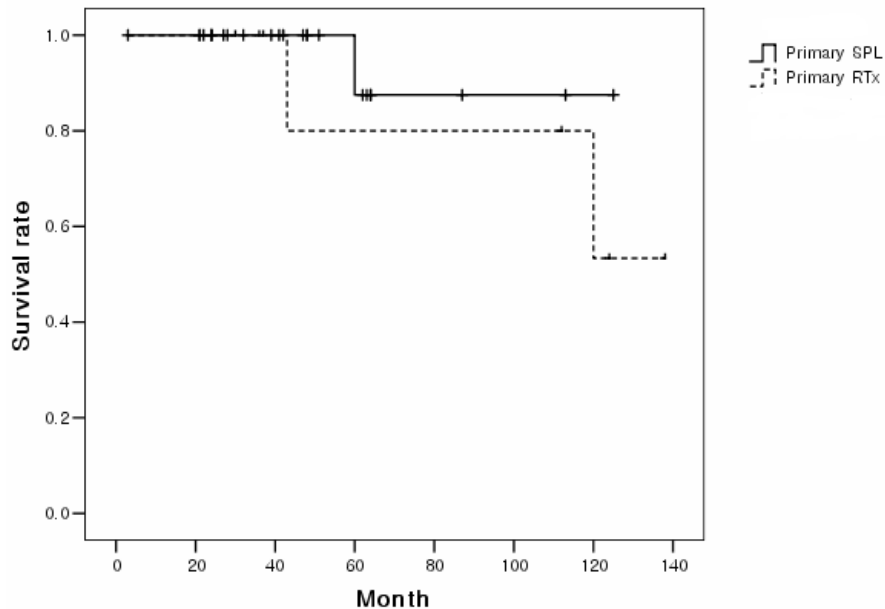


Fig 2. Overall survival (stage I, II)



Survival rates of patients who were diagnosed as supraglottic carcinoma (stage III or IV) and whose treatment was initiated by supraglottic partial laryngectomy or radiation therapy were analyzed. The 5-year disease-free survival rate was 85% in patients whose treatment was initiated by supraglottic partial laryngectomy, and 52% in patients whose treatment was initiated by radiation therapy, with no significant difference ( $p=0.338$ ). The overall 5-year survival rate was 83% and 61%, respectively with no significant difference. ( $p=0.058$ ) (Figure 1, 2)

Fig 3. Disease-free survival (stage III, IV)

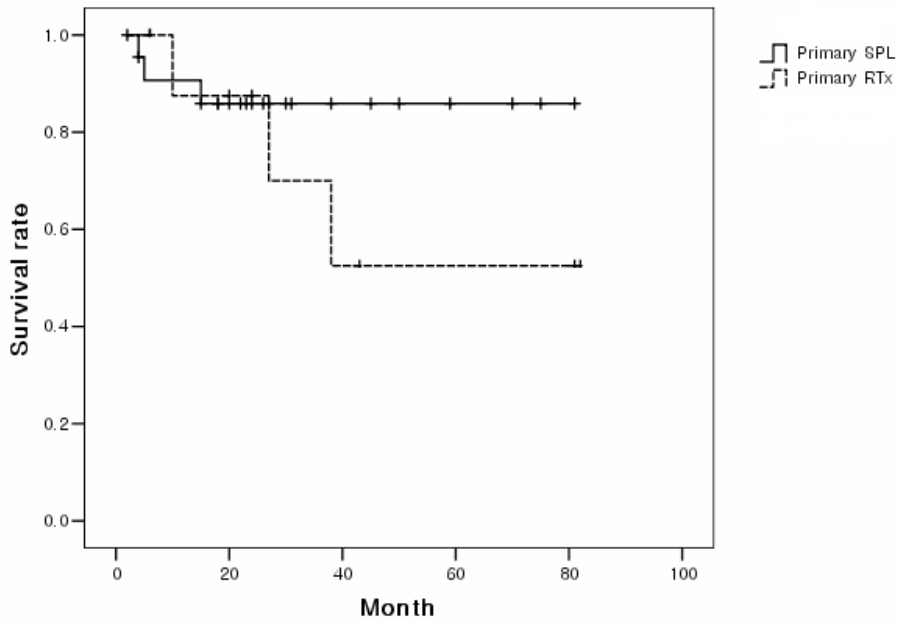
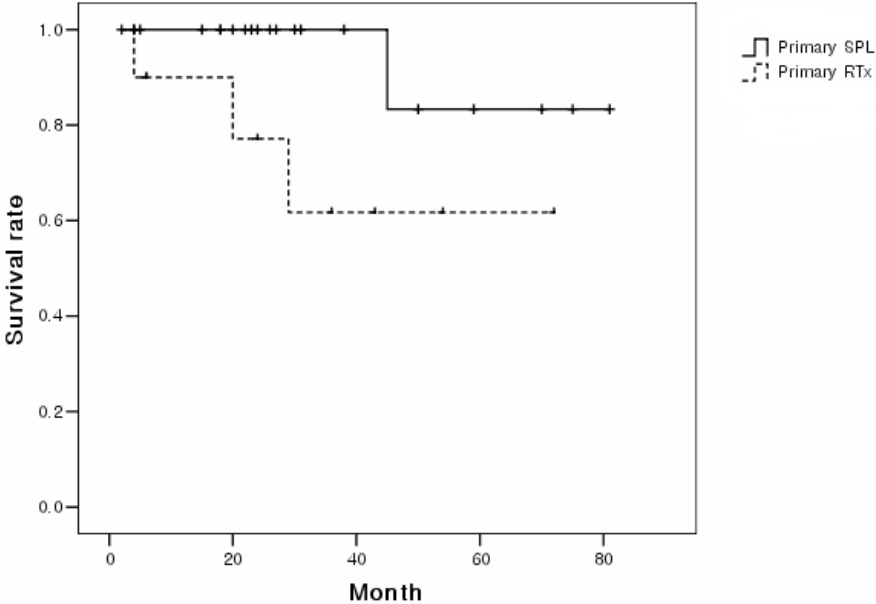


Fig 4. Overall survival (stage III, IV)



### 3. Functional evaluation

Functional test was performed on patients diagnosed as early supraglottic carcinoma and whose treatment was completed by initial therapy. For the functional evaluation of swallowing, videoesophagofluoroscopy was applied, and depending on treatment methods, it was compared by the pharyngeal phase and the presence or absence of aspiration. Incompetence of closure of the larynx was detected in 4 cases (26 %) in the supraglottic partial laryngectomy group and 2 cases (20 %) in the radiation therapy group, and liquid aspiration was detected in 1 case (6%) in the supraglottic partial laryngectomy group, but no significant difference was noted ( $p>0.05$ ). (Table 6)

Table 6. Swallowing abnormalities according to videoesophagofluoroscopy

	Only SPL (n=15) n(%)	Only RTx (n=10) n(%)
<b>Pharyngeal phase</b>		
Delayed swallowing reflex	-	-
Incompetent closure of velopharyngeal port	-	-
Reduced pharyngeal peristalsis	-	-
Reduced elevation of larynx	-	-
Incompetence of closure of larynx	4 (26%)	2 (20%)
Cricopharyngeal dysfunction	-	-
<b>Aspiration</b>		
During swallowing (liquid)	1 (6%)	-

Vocal cord vibration was examined under stroboscopy. Abnormalities of the mucosal wave were detected in 2 cases (13 %) of the supraglottic partial laryngectomy group and in 2 cases (20 %) of the radiation therapy group, but no significant difference was noted. Nonspecific abnormal findings were shown in other categories, but no significant difference was shown (Table 7).

Table 7. Abnormalities of vocal cord vibration according to stroboscopy

	Only SPL (n=15)	Only RTx (n=10)
	n (%)	n (%)
Regularity	-	1 (10%)
Symmetry	1 (7%)	1 (10%)
Glottic closure	1 (7%)	-
Mucosal wave	2 (13%)	2 (20%)
Amplitude	-	1 (10%)
Non-vibrating portion	-	-

Phonological analysis was performed using acoustic waveform analysis. Grossly, the variance against frequency, the variance against amplitude, and the noise level were analyzed, and none of the categories showed a significant difference between the two groups. (Table 8)

Table 8. Acoustic waveform analysis

	Only SPL (n=15)	Only RTx (n=10)	p value
Jita (us)	62.67± 16	60.66± 22	> 0.05
Jitt (%)	0.65± 0.14	0.60± 0.19	> 0.05
RAP (%)	0.45± 0.09	0.37± 0.11	> 0.05
PPQ (%)	0.42± 0.15	0.32± 0.10	> 0.05
sPPQ (%)	0.75± 0.13	0.69± 0.13	> 0.05
V Fo	1.08± 0.27	1.16± 0.28	> 0.05
ShdB (dB)	0.46± 0.09	0.38± 0.11	> 0.05
Shim (%)	4.85± 1.05	4.52± 1.03	> 0.05
APQ (%)	3.89± 0.31	3.43± 0.75	> 0.05
sAPQ (%)	4.99± 1.13	4.93± 0.86	> 0.05
vAm	14.82± 2.30	13.38± 2.63	> 0.05
NHR	0.17± 0.05	0.15± 0.03	> 0.05
VTI	0.02± 0.005	0.02± 0.009	> 0.05
SPI	49.69± 20.13	44.69± 26.15	> 0.05

#### **IV. DISCUSSION**

The most appropriate treatment method for early supraglottic carcinoma is still largely controversial. The current treatment methods being applied are supraglottic partial laryngectomy, supracricoid partial laryngectomy, radiation therapy alone, radiotherapy or surgery in adjuvant with chemotherapy and endoscopic laser surgery,<sup>8</sup> and although there are reports of oncological as well as functional outcomes of each methods, in reality it is difficult to retrospectively compare the outcomes due to the fact that each institution adopts different treatment methods under preference.

The oncologic safety of supraglottic partial laryngectomy has been proven through numerous studies, and together with radiation therapy, it shows high local control rates on early supraglottic carcinomas. However, due to the consideration that radiotherapy is advantageous in the functional preservation of the larynx, curative radiation therapy has been recommended as the initial mode of therapy.<sup>3,4,5</sup> However, through several recent studies, there have been reports of swallowing and phonation impairment caused by radiation therapy. Eisbruch<sup>9</sup> and others have reported in a study comparing the swallowing ability prior to and after concurrent chemoradiation therapy, that the incidence of aspiration was increased due to swallowing difficulty developed after therapy, and consequently, the incidence of aspiration pneumonia was notably increased.

Peter and others<sup>10</sup> have reported the change caused by the apoptosis of mucosal stem cells induced by radiation therapy, and Kaanders, Trotti and others<sup>11,12</sup> have reported that the deterioration of laryngeal function was induced by acute inflammatory reaction of the mucosa and the late fibrotic change. In addition, when performing conservation laryngeal surgery as salvage treatment after failure of radiation therapy, it is difficult to obtain safe surgical margins, and so an objective analysis as to whether radiotherapy is appropriate as the initial treatment in early supraglottic carcinoma is necessary.

Supraglottic partial laryngectomy is a surgical technique that could preserve the voice completely, and according to the study reported by Gonzalez, Maurizi and others<sup>13,1</sup>, the incidence of postoperative decannulation failure that has been known to be the biggest shortcoming of the technique and complications caused by aspiration were very low, and 5-year disease-free survival rate has been reported from 62 % to 90 %.<sup>1,14-16</sup> In addition to the therapeutic benefits, Isaacs<sup>17</sup> and others have suggested the advantages of supraglottic partial laryngectomy as follows: (1) if other malignant tumors were synchronously developed in the head and neck area, radiation therapy could be performed additionally; (2) depending on surgical pathology, radiation therapy could be performed additionally; (3) there is no chronic tissue injury which can result from radiation therapy; (4) physical examination during follow up is more facilitated due to the removal of the epiglottis. Therefore, this study is significant in the sense that supraglottic partial laryngectomy is objectively



evaluated in comparison to radiotherapy in aspects of oncologic safety and functional preservation.

The most important factor associated with the recurrence of the primary site is the positivity of the resection margins. In this study, the location of the resection margins according to the primary site was analyzed, and in cases where the primary site was located superior such as the suprahypoid epiglottis, high incidence of positive resection margins was observed in the superior aspect of the surgical specimen and where the primary was the infrahypoid epiglottis or the false vocal cord, positive resection margins were observed in the inferior aspect of the surgical specimen. Such results show that during surgery, the primary site must be considered to obtain safe resection margins. The locative association between the site of positive resection margin or the primary tumor with the site of recurrence was investigated, but due to the small incidence of recurrence, statistically significant results could not be obtained. According to the multivariate analysis, prognosis was affected by clinical nodal stage only, not by other factors including positivity of resection margin.

According to the study reported by Weems and others, the overall 5-year survival rate according to stage was 100% for both stage I, II in curative radiotherapy group and 100% for stage I and 88.8% for stage II in the surgery group.<sup>19</sup> In addition, the local control rate according to T stage was 100 % for T1 and 89 % for T2 in the curative radiation therapy group, and 100% for T1 and 84% for T2 in the surgery group. The 5-year disease-free survival rate of

supraglottic partial laryngectomy alone is reported 62 % to 90 %.<sup>1,14-17</sup> In our study, analysis was done including stage I and II, and it has been noted that the overall 5 year survival rate of the surgery group was 87 % and the radiation therapy group was 80 %. The 5-year disease-free survival rate of the surgery group was 89 % and the radiation therapy group was 100%, and all did not show a statistically significant difference. In stage III and IV, the overall 5 year survival rate of the surgery group was 83% and the radiation therapy group was 61%. The 5-year disease-free survival rate of the surgery group was 85 % and the radiation therapy group was 52%, and all did not show a statistically significant difference. It is considered that the difference of the survival rates compared with other previous studies is due to the difference of the number of patients.

On functional evaluation of supraglottic partial laryngectomy, previous studies were limitedly focused on parameters such as the ability for oral intake, continuous aspiration or its consequent complications and chances for decannulation. Therefore, in this study, efforts have been made to more objectively evaluate functional results through swallowing evaluation and phonological analysis with comparison to radiation therapy. From the results of videoesophagofluoroscopy, incompetence of closure of the larynx was detected in both surgery group and radiation therapy group, but no significant difference was shown. Closure of the larynx is a delicate laryngeal function brought about by the action of the vocal cord, the false vocal cord and finally the epiglottis. In

the surgery group, the epiglottis has been removed and thus obvious functional deterioration was anticipated, however, in the radiation therapy group, due to the decrease of the epiglottal movement, partial deterioration of function was observed also. The development of aspiration was detected in 1 case (6 %) of the surgery group however, the patient was adjusted to most routine life, and there were no consequent complications. Eisbruch and others have reported similar results that the major causes of swallowing disorders related to chemoradiotherapy are the displacement of the epiglottis and the decreased movement of the base of tongue.<sup>9</sup>

In this study, vocal cord vibration and phonological analysis were performed using stroboscopy and acoustic waveform analysis respectively. Both groups showed non-specific findings and there was no statistically significant difference. Supraglottic partial laryngectomy is a surgical technique that removes the upper structure of the glottis while preserving the vocal cord, and though it leads to the decrease of the resonance space, it is considered that it does not mediate great phonological effects, and also the influence of radiation therapy is considered minimal. For more accurate functional evaluation, it is thought that comparative studies with phonological test results obtained prior to treatment are required.

## **V. CONCLUSION**

In the treatment of early supraglottic carcinoma, the primary purpose should be the complete removal of tumors, nevertheless, the aspect of the conservation of laryngeal function is also an important issue to be considered. From this study, in comparison with radiation therapy that has been preferentially considered for functional aspects, supraglottic partial laryngectomy was found to show equal results in terms of oncologic safety and functional preservation.

This is a study that confirms the appropriateness of supraglottic partial laryngectomy as the initial treatment for supraglottic carcinomas, and it may become a reference guideline to explain the prognosis of treatment to patients in the future.

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## ABSTRACT(In Korean)

성문상부암에서 성문상 부분 후두절제술의  
종양학적 안정성과 기능의 보존

<지도 교수 김 세 현>

연세대학교 대학원 의학과  
천 제 영

방사선 치료는 후두를 보존한다는 측면에서 수술적 치료에 비하여 발성과 연하작용에 있어 기능적으로 우수한 결과를 보인다고 평가되었으나, 여러 연구를 통하여 방사선 치료 후 점막염과 후기 섬유화로 인한 발성과 연하작용의 장애가 보고된 바 있다. 또한 재발로 인해 추가 치료를 선택할 경우 보존적 후두 절제술을 시행하는데 한계가 있어, 초치료로서의 적절성 여부에 대하여 고려되어야 할 필요가 있다. 따라서 본 연구는 기능적 보존이 가능한 성문상 부분 후두절제술과 방사선 치료와의 비교 연구를 통하여 조기 성문상부암의 초치료로서 보존적 수술의 적절성을 평가하고자 한다.

본 연구는 1991년 5월부터 2005년 5월까지 세브란스병원 이비인후과에서 조기 성문상부암으로 진단 받고 초치료로 성문상 부분 후두절제술을 시행 받은 환자 48명과 방사선 치료를 받은 환자 20명을 대상으로 의무기록을 후향적으로 검토하였고 초치료로 치료가 종결된 환자를 대상으로 연하와 발성기능을 평가하였다. 그 결과 두 그룹간의 생존률에 있어 차이를 보이지 않았고 연하와 발성기능 평가에 있어서도 동등한 수준의 기능 보존이 확인되었다.



이를 통해 조기 성문상부암 환자에 있어서 성문상 부분 후두절제술은, 방사선 치료와 비교시 적절한 수준의 종양학적 안정성과 기능의 보존이 가능한 술식으로 사료된다.

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핵심되는 말 : 성문상 부분 후두절제술, 방사선치료, 연하, 발성